HVAC 101

The Basics of Heating, Ventilation and Air Conditioning

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Southface Energy Institute

Southface Energy Institute

Sensible Solutions for Environmental Living

- *Energy Code Workshops*
- *Greenprints*
- *Commercial Systems*
- *EarthCraft House*

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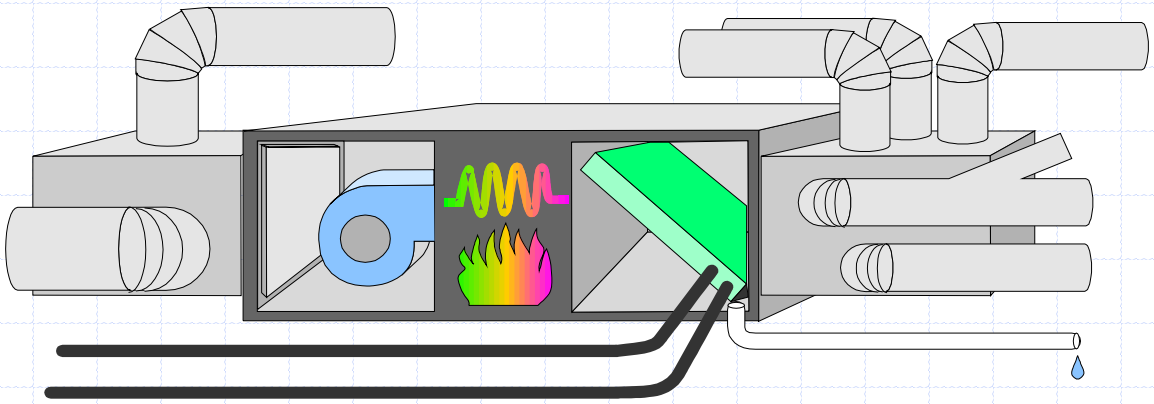
HVAC

- Heating, Ventilation and Air Conditioning
- Provides *comfort* for people
- Allows humans to *exist* under adverse conditions.

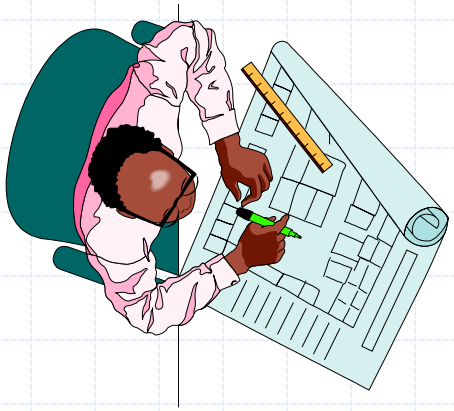


Comfort

- Comfort is primary intent of HVAC systems.
- Productivity
- Building Durability
- Health
- Mold

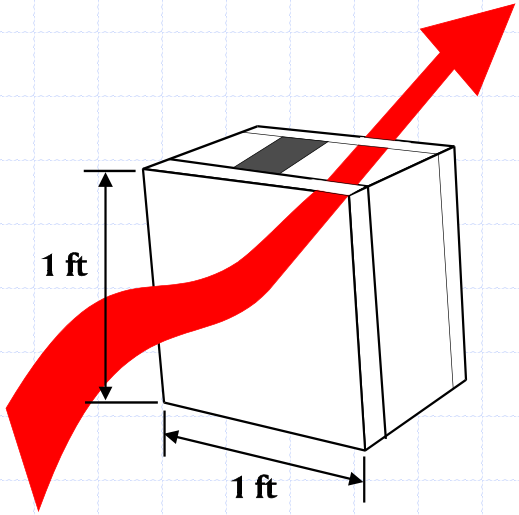
Load Calculations

- Heating and Cooling
- Accuracy *important!*
- Design conditions
- Building shell load
- R, U value
- Internal load
- Ventilation load
- Infiltration
- Occupancy schedules



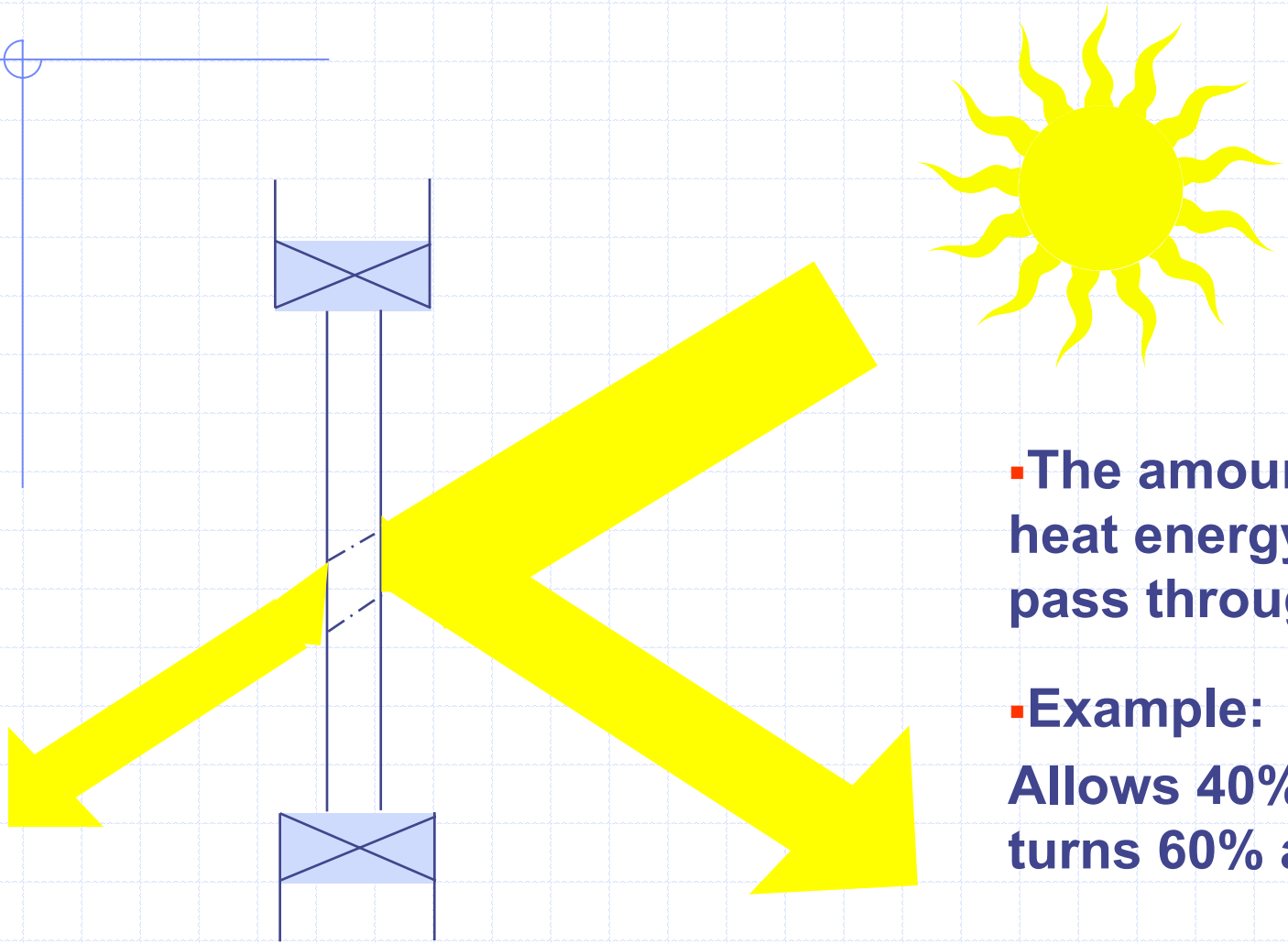
Heat Transfer

- Conduction
- Convection
- Radiation
- Resistance (R-Value)
- U = 1 / R
- Q = U x A x ΔT



U-Value is the rate of heat flow in Btu/h through a one ft^2 area when one side is 1^oF warmer

Solar Heat Gain Coefficient

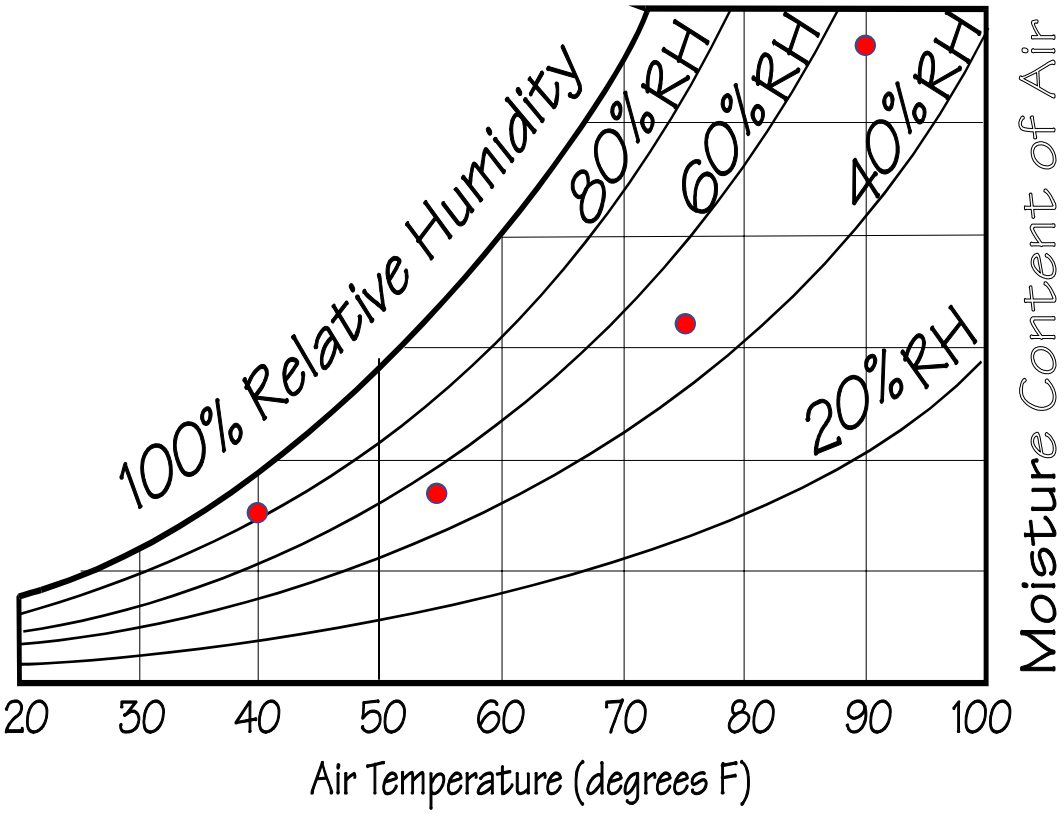


- The amount of solar heat energy allowed to pass through a window
- Example: SHGC = 0.40

Allows 40% through and turns 60% away

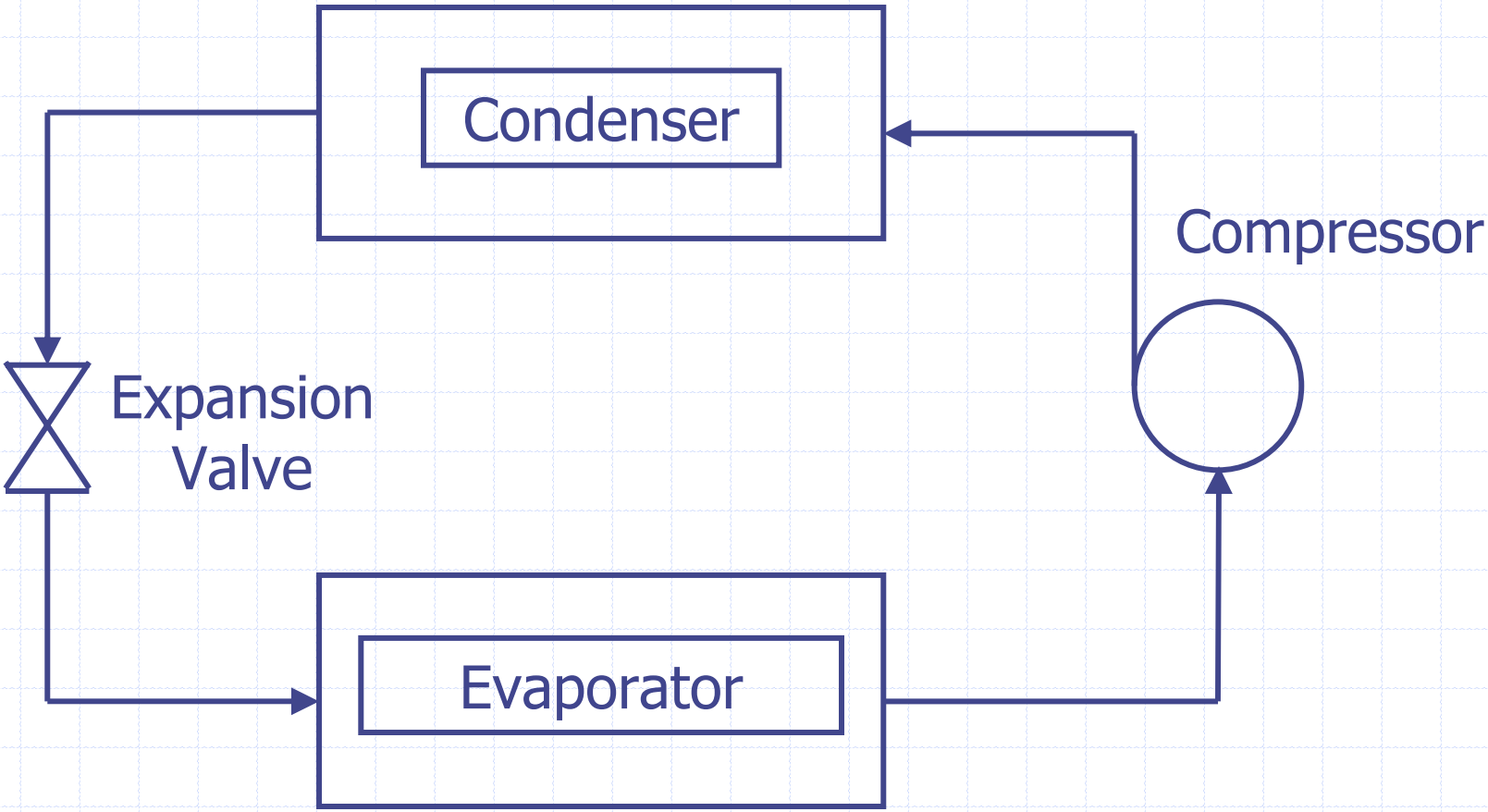
Psychrometrics

- Dry bulb temp.
- Wet bulb temp.
- Humidity
- Dew point
- Moisture content
- Heating
- Cooling
- Humidify
- De-Humidify



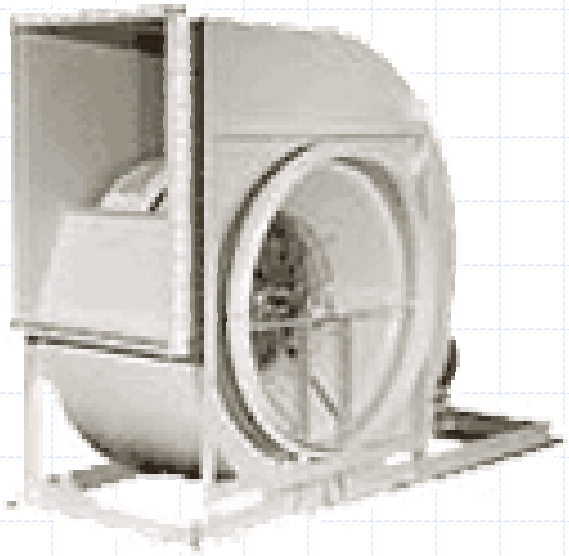
Psychrometric Chart

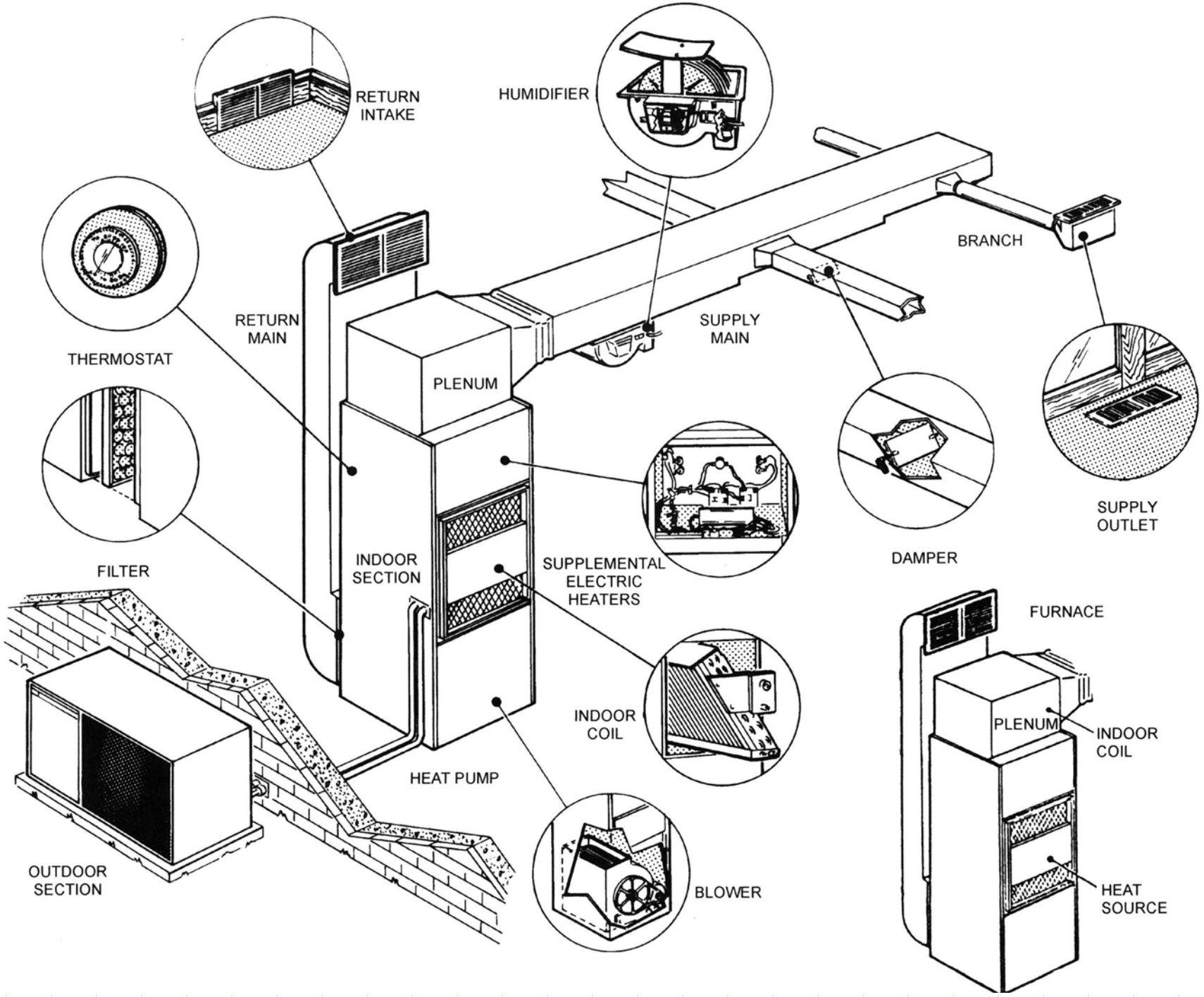
Basic Refrigeration Cycle



Basic HVAC Equipment

- Fans / Blowers
- Furnace / Heating unit
- Filters
- Compressor
- Condensing units
- Evaporator (cooling coil)
- Control System
- Air Distribution System

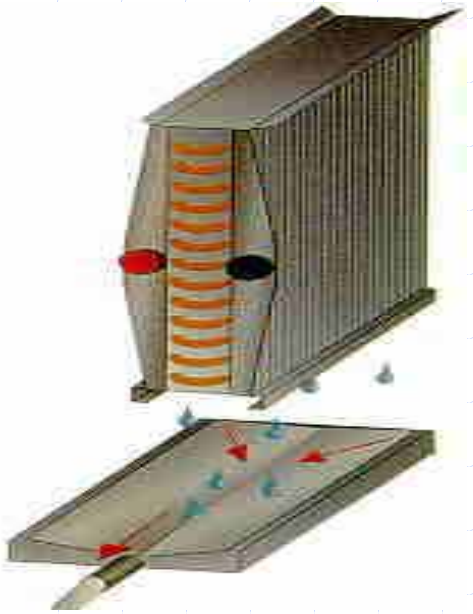



RETURN INTAKE
HUMIDIFIER
THERMOSTAT
RETURN MAIN
SUPPLY MAIN
BRANCH
PLENUM
SUPPLY OUTLET
FILTER
INDOOR SECTION
SUPPLEMENTAL ELECTRIC HEATERS
DAMPER
FURNACE
INDOOR COIL
HEAT PUMP
PLENUM
INDOOR COIL
OUTDOOR SECTION
BLOWER
HEAT SOURCE

System Types and Common Terms

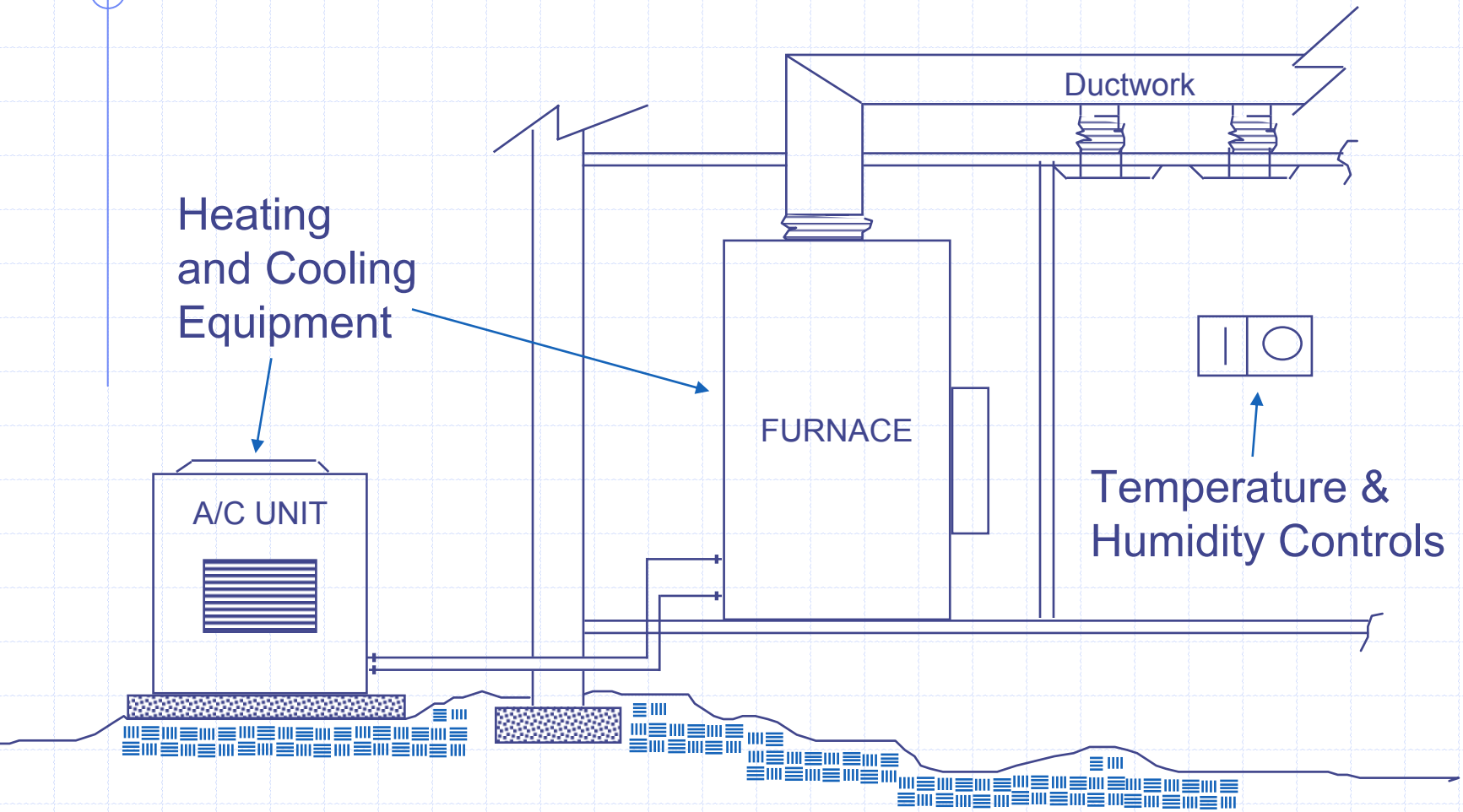
- Packaged Rooftop Unit
- Split System
- Heat Pump
- Geothermal
- Air to Air
- Hydronic (water)
- PTAC / PTHP

- Constant Volume
- Variable Volume
- Indoor Air Quality
- Direct Expansion



Packaged Rooftop Units

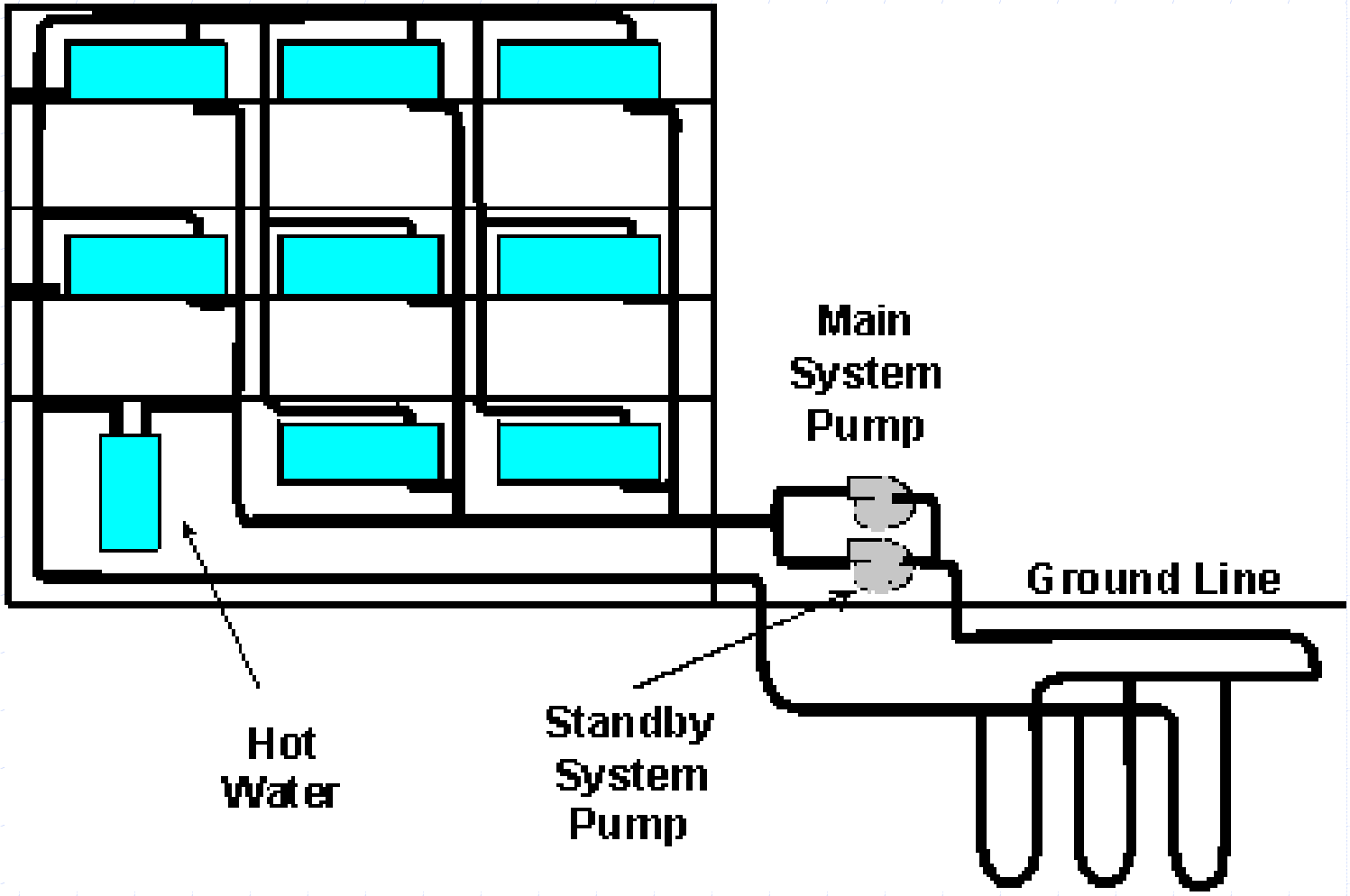
Split System



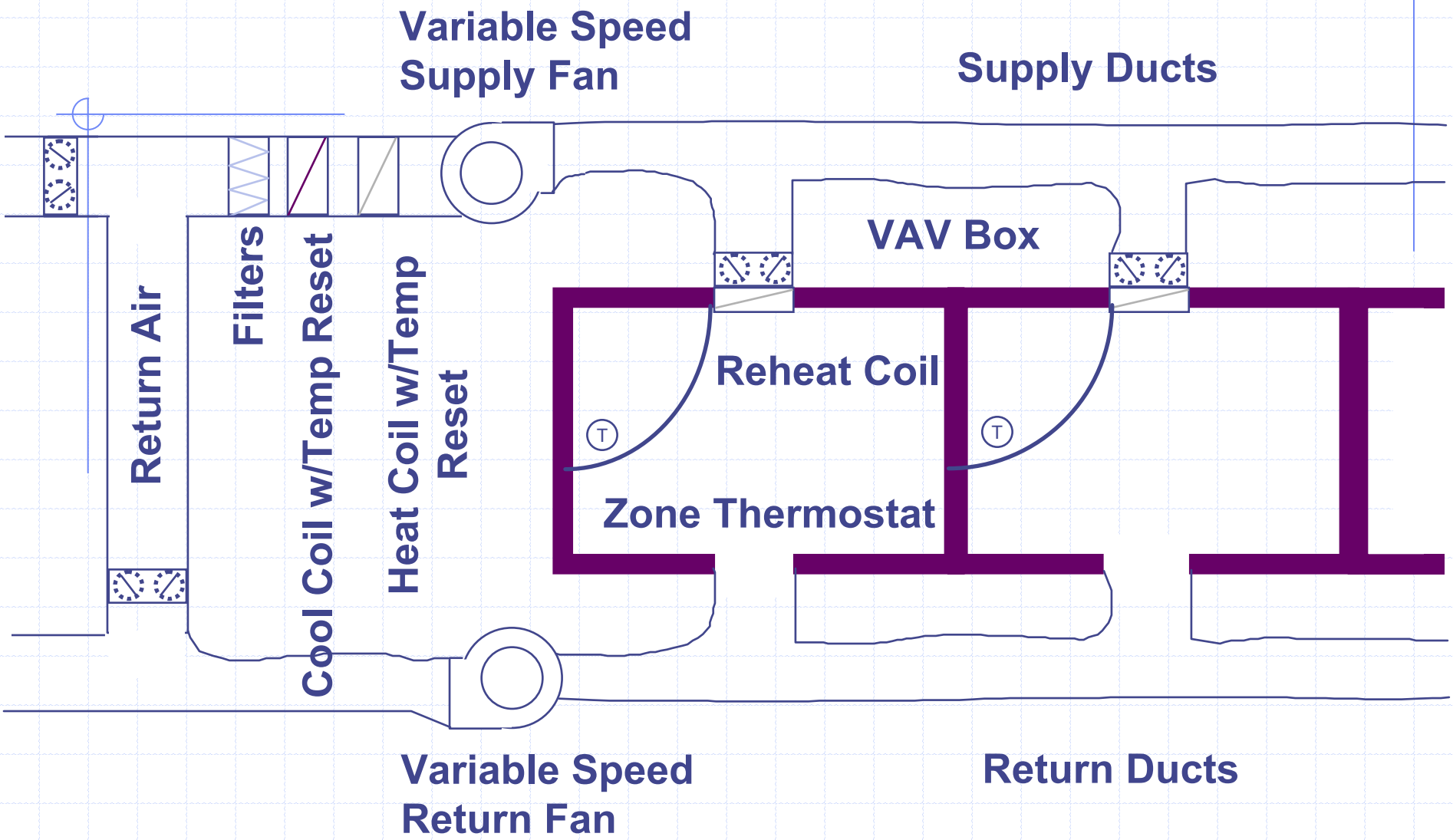
Heat Pump

- Operate on simple refrigeration cycle
- Reversing the cycle provides heating
- Temperature limitations
- Air to air
- Water source
- Geothermal
- Lake coupled

Geothermal Heat Pump Systems



Variable Air Volume



Terminal Units

Variable volume:
Parallel

Constant volume:
Series

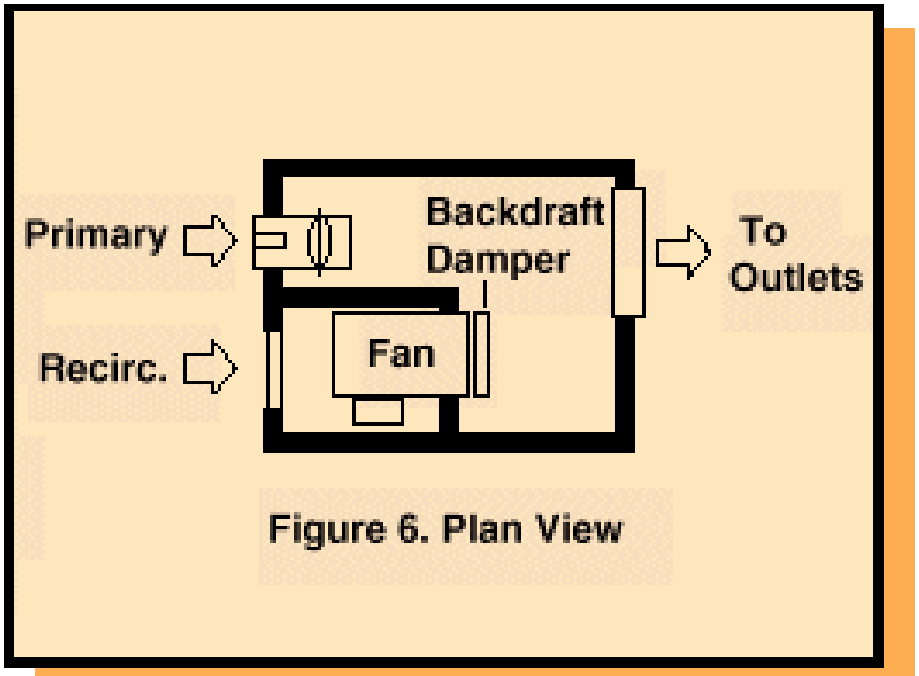


Figure 6. Plan View

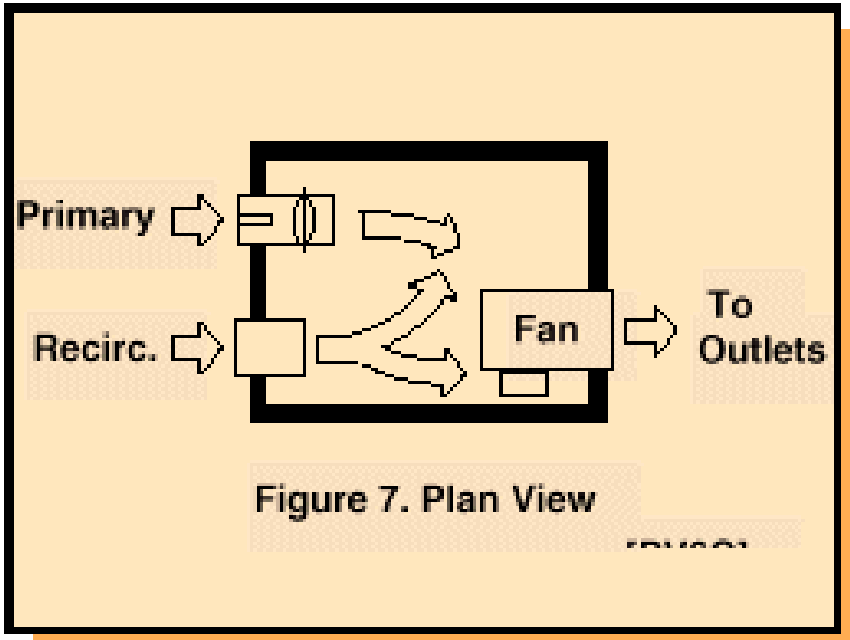


Figure 7. Plan View

Hydronic systems

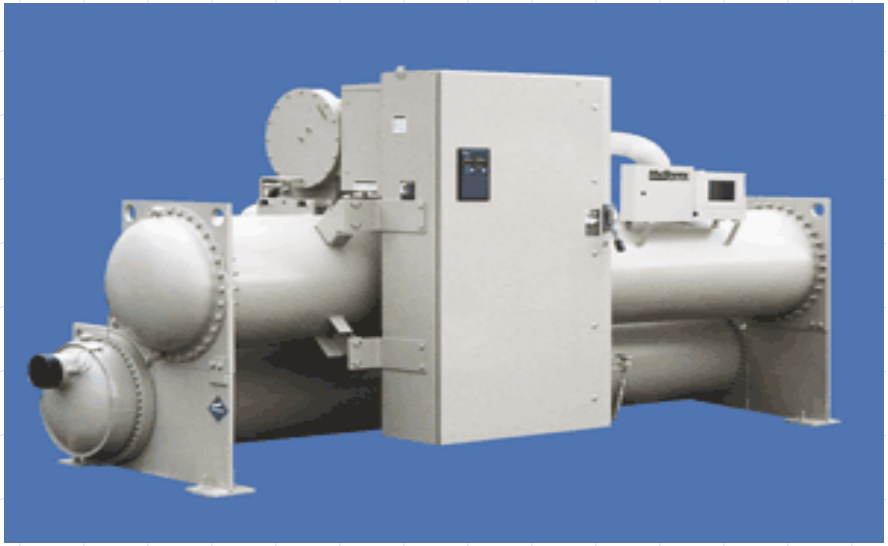
- Pumps
- Piping
- Valves

Control Devices

- Thermostats
  - Manual
  - Programmable
- Optimum Start
- DDC Systems
- Variable Speed Drives
- Automatic Valves and Dampers
- Outdoor Sensors

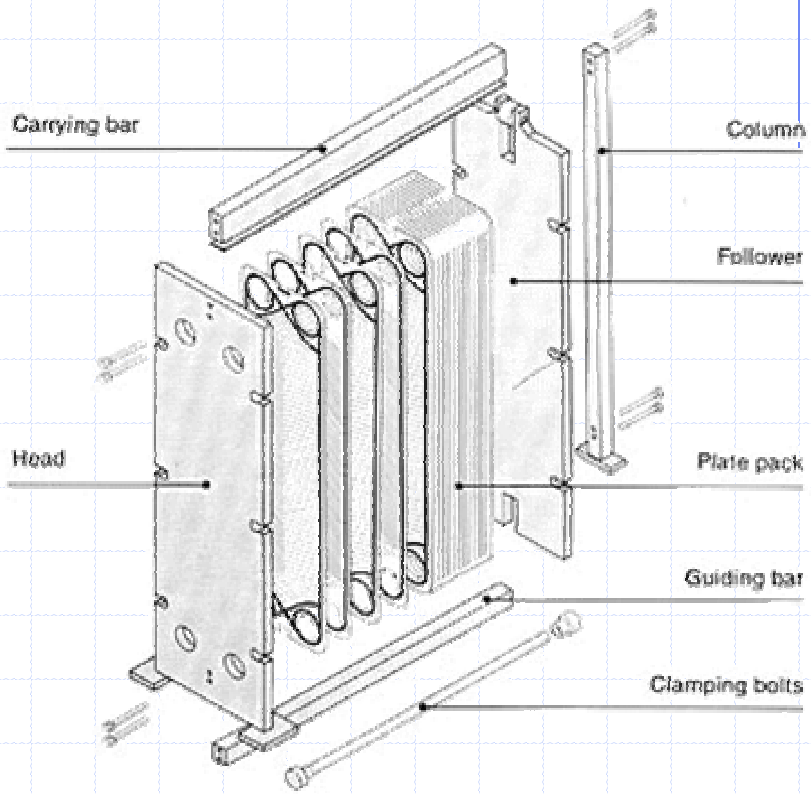
Major Equipment

- Chillers
- Boilers
- Cooling Towers



Economizers

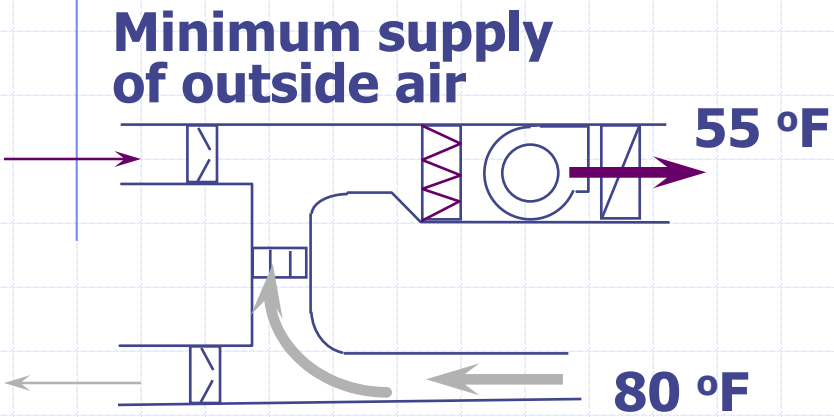
Air Side

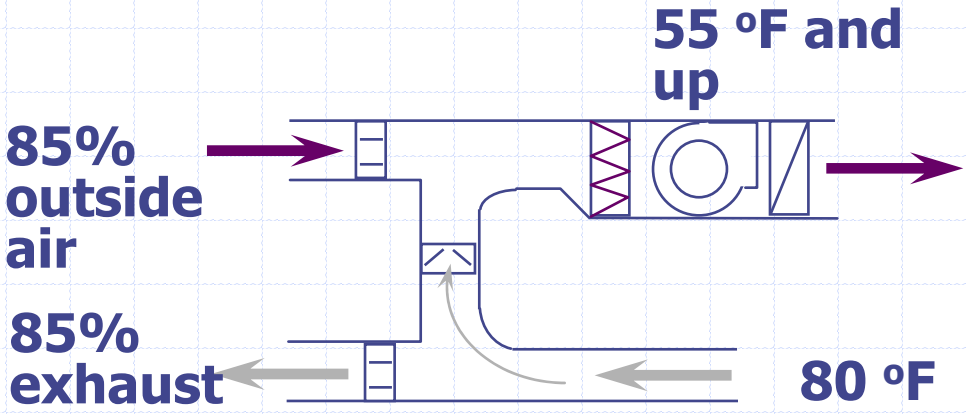


Water Side

Economizers

Free cooling source: When available, use cool outdoor air instead of mechanically cooled air.





Normal Operation

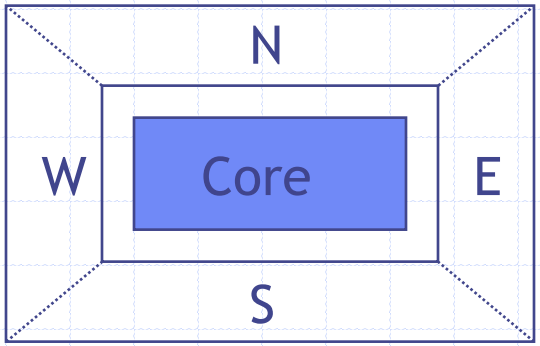
Outside air dampers are positioned to provide the minimum outside air

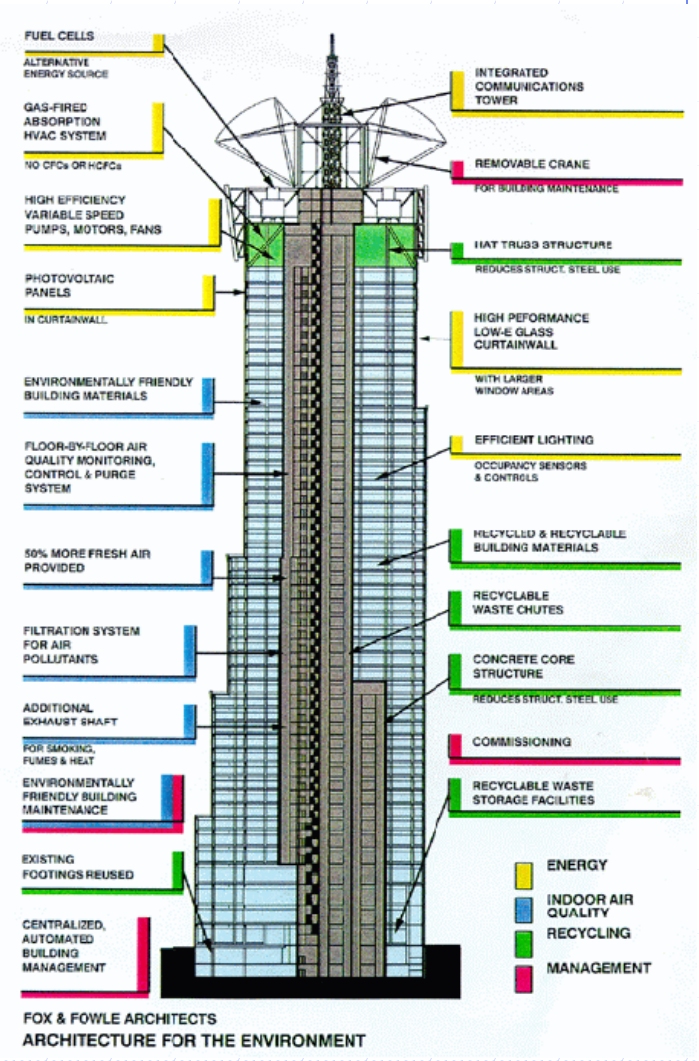
Economizer Operation

Outside air dampers are fully open. Maximum outside air is provided

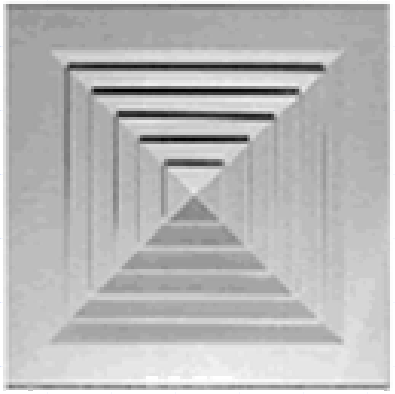
Zoning and Economizers

- Economizers provide "free cooling" when outdoor conditions are optimal
- Proper orientation & zoning yields comfort & efficiency



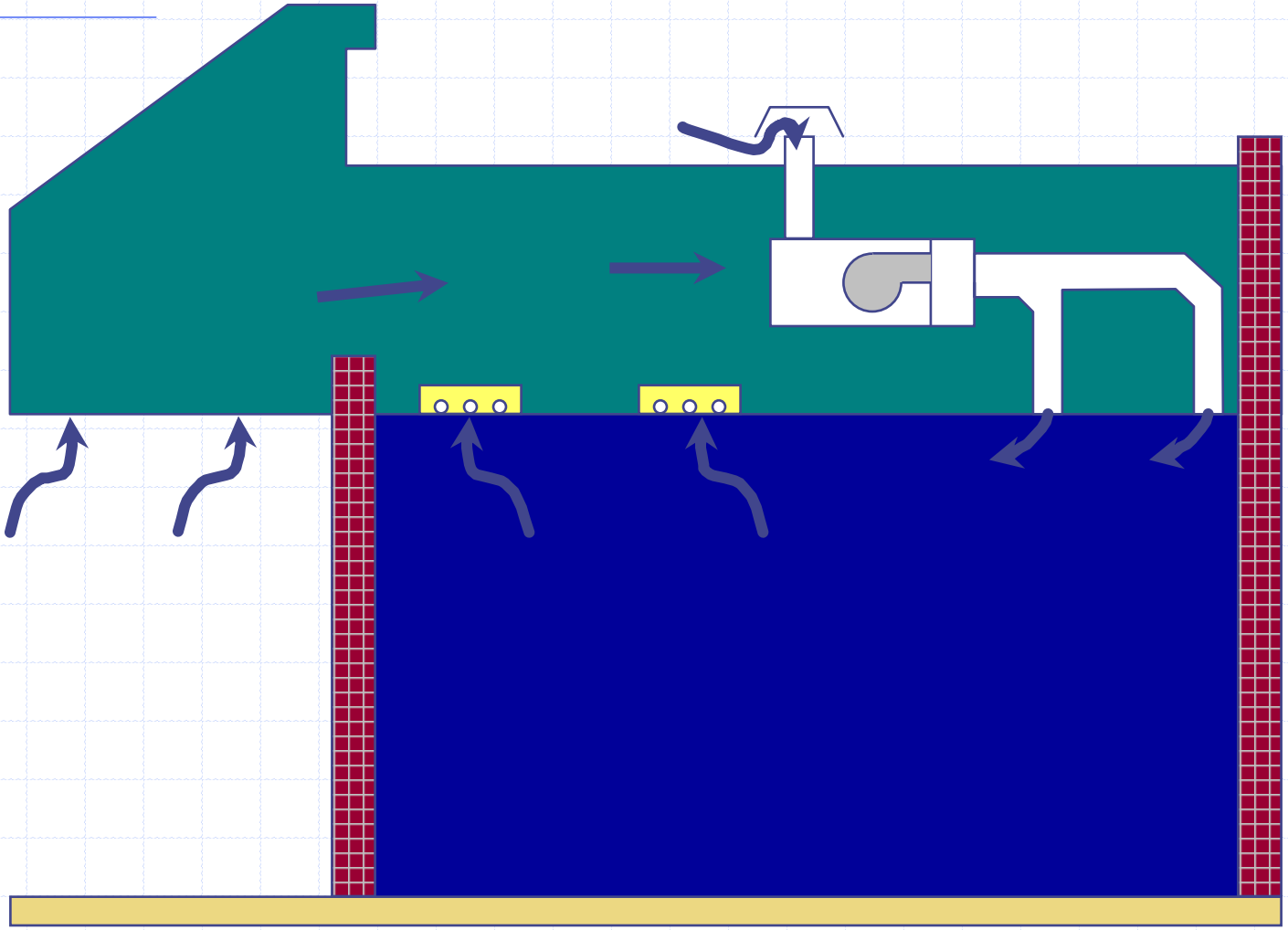


Air Distribution



- Ductwork
  - Metal
  - Flexible
  - Ductboard
- Grilles, Louvers, & Registers
- Dampers
  - Shut off
  - Fire
  - Smoke
- Sealants
- Supports

Return Plenum Problems

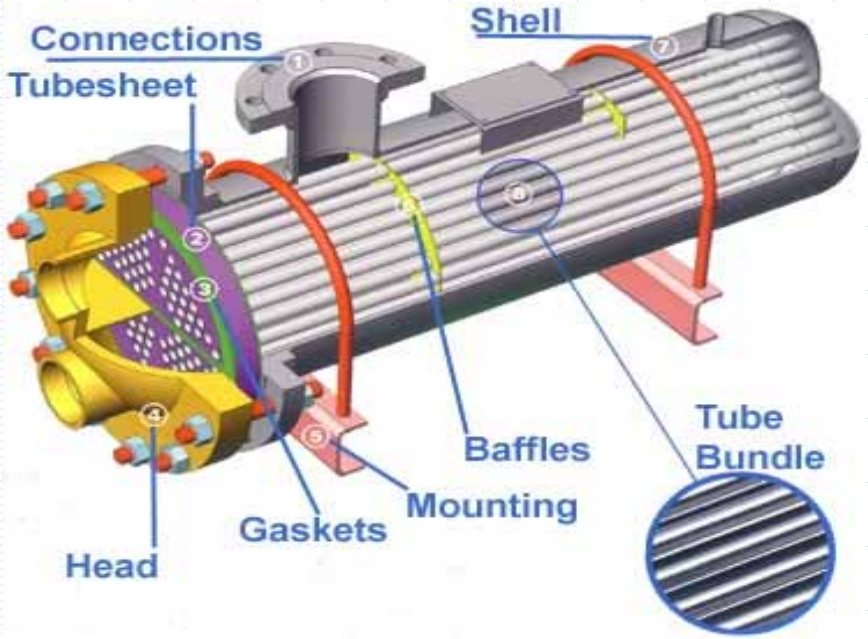


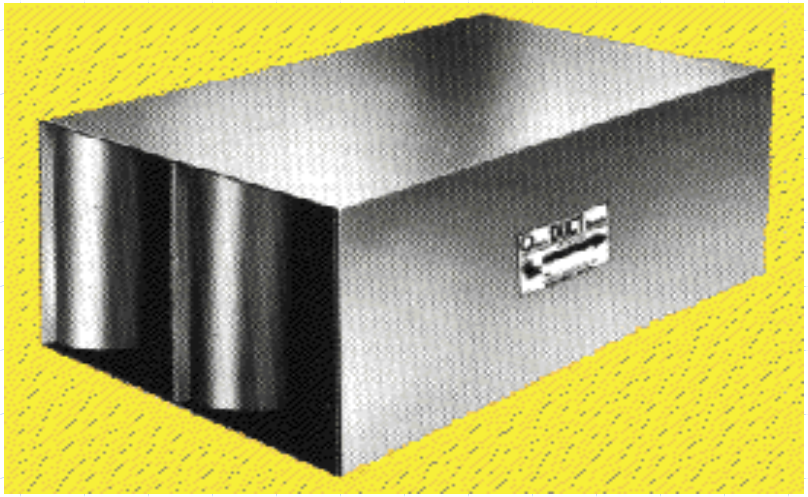
Additional Equipment

- Energy Recovery Units
- Desiccant Systems

Additional Equipment

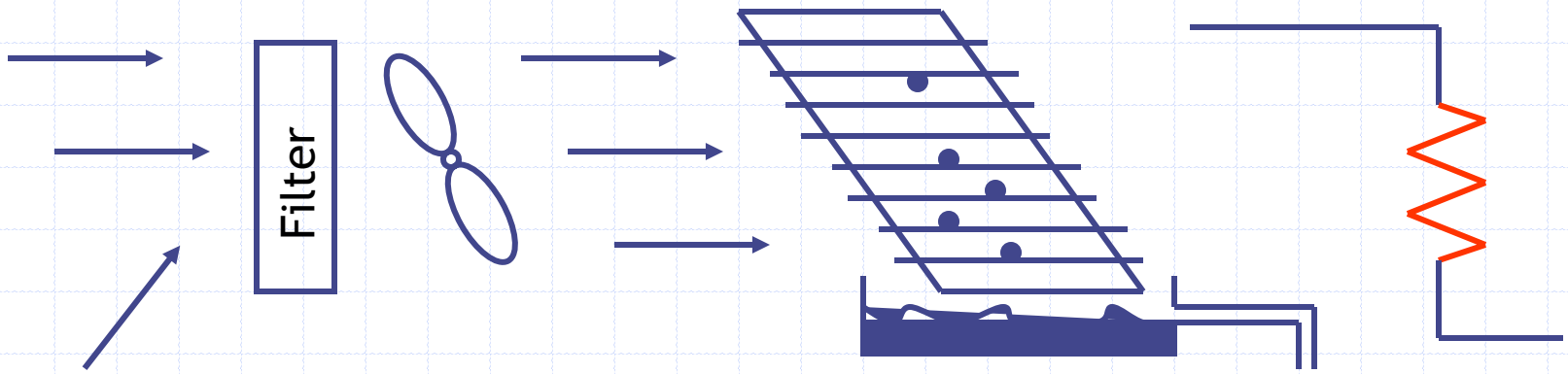
- Heat Exchangers
- Humidifiers
- Silencers



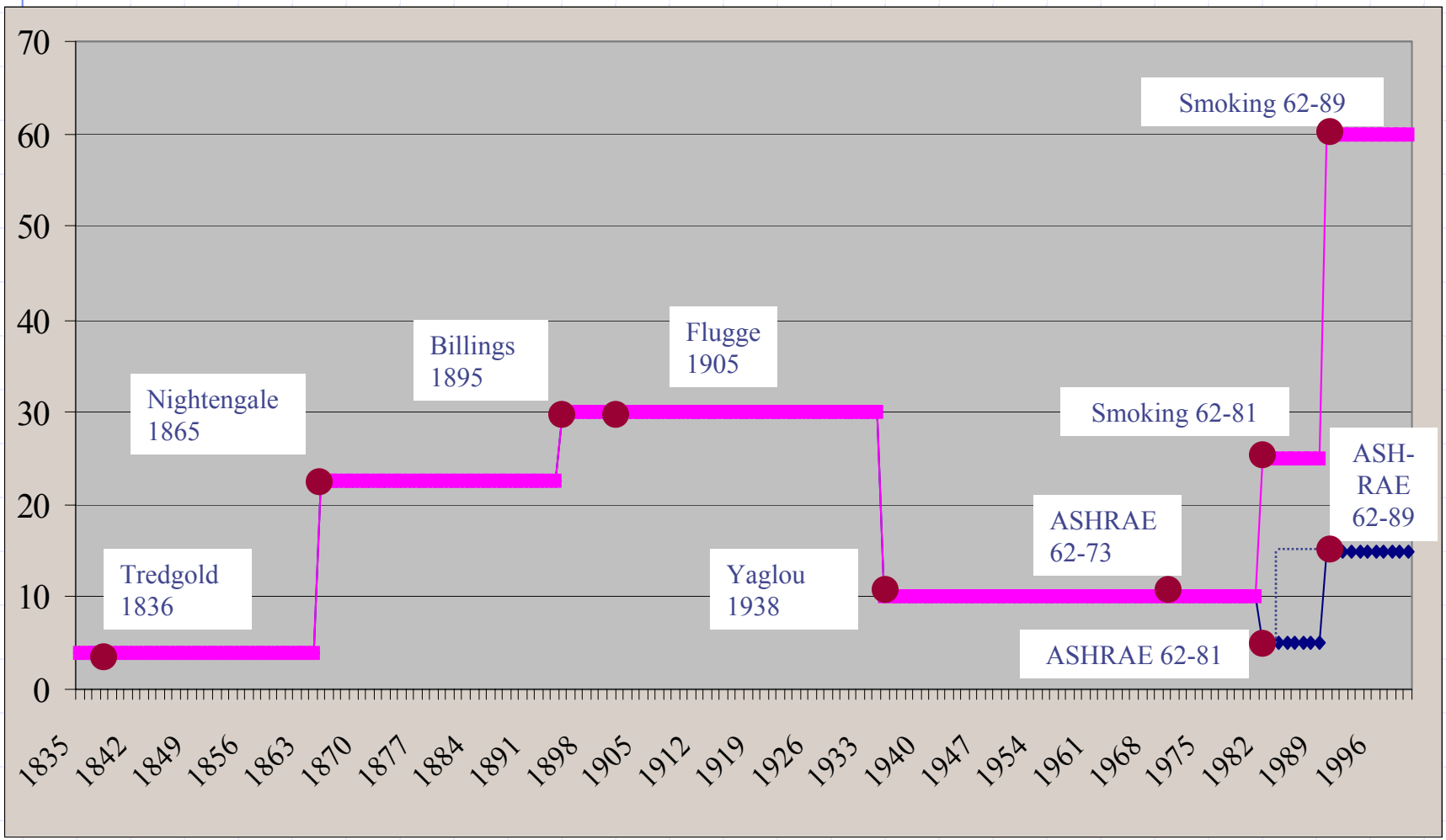


Mechanical Dehumidification

- Return air is mixed with ventilation air
- Cold coil condenses moisture
- Heat is added back (electric or gas) so that room air is not over cooled- *Reheat*



Historical Minimum Ventilation Rates (cfm/person)



Improved Ventilation Effectiveness

- Mechanically provide filtered and dehumidified outdoor air to the breathing space
- Vary ventilation based on the number of occupants and process loads - changes in occupancy can be measured by CO_2 sensors
- Consider designs that separate ventilation and space conditioning
- Utilize heat recovery systems to reduce system size and ventilation energy costs

Improved Ventilation Effectiveness

- Effective mixing of ventilation air within space
- Net positive pressure in the southeast; exhaust from appropriate spaces
- Provide clean outdoor air, avoid:
  - loading docks
  - exhaust vents
  - plumbing stacks
  - waste collection
  - stagnant water

Additional Information / Resources

- ASHRAE – The American Society of Heating, Refrigerating and Air-Conditioning Engineers
  - www.ashrae.org
- Southface Energy Institute www.southface.org
- Geothermal heat pump consortium www.geoexchange.org
- www.buildingscience.com
- www.energycodes.gov